IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES
Docket No. 13445US02

IN THE APPLICATION OF:

Oscar E. Agazzi

SERIAL NO.: 09/765,014

FILED: January 17, 2001

FOR: HIGH-SPEED TRANSMISSION SYSTEM FOR OPTICAL CHANNELS

ART UNIT: 2613

EXAMINER: David S. Kim

Conf. No.: 7258

Electronically Filed on <u>July 2, 2008</u>

BRIEF ON APPEAL

Mail Stop: Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This is an appeal from an Office Action dated July 11, 2007, in which claims 1, 5-9, 11, 12, 16, 18-20, 22, 23, 28, 31, 32, 36-38, 41, 42, 45, 57, 60, 61, 64, 65, 69-71, and 74 were finally rejected.

REAL PARTY IN INTEREST

Broadcom Corporation, a corporation organized under the laws of the state of California, and having a place of business at 5300 California Avenue, Irvine, California 92617, has acquired the entire right, title and interest in and to the invention, the application, and any and all patents to be obtained therefor, as set forth in the Assignment recorded at Reel 011679, Frame 0588 in the PTO assignment search room.

RELATED APPEALS AND INTERFERENCES

There currently are no appeals pending regarding related applications.

STATUS OF THE CLAIMS

Claims 1, 5-9, 11, 12, 16, 18-20, 22, 23, 28, 31, 32, 36-38, 41, 42, 45, 57, 60, 61, 64, 65, 69-71, and 74 are pending in the present application. Claims 2-4, 10, 13-15, 17, 21, 24-27, 29-30, 33-35, 39-40, 43-44, 46-56, 58-59, 62-63, 66-68, 72-73, and 75-80 were previously cancelled. Pending claims 1, 5-9, 11, 12, 16, 18-20, 22, 23, 28, 31, 32, 36-38, 41, 42, 45, 57, 60, 61, 64, 65, 69-71, and 74 stand rejected and are the subject of this appeal.

STATUS OF THE AMENDMENTS

None.

SUMMARY OF CLAIMED SUBJECT MATTER

Claim 1 is directed to a method for high-speed transmission of information data on an optical channel. Pursuant to said method, information is encoded via a trellis encoder to produce digital multilevel symbols. The digital multilevel symbols are equalized to compensate for characteristics of the optical channel. Said equalizing comprises precoding the digital multilevel symbols using a Tomlinson-Harashima precoder. The digital multilevel symbols are converted into analog multilevel signals, and the analog multilevel signals are transmitted over the optical channel.

The invention of claim 1 is illustratively described in the Specification of the present application at, for example, page 5, line 32 – page 7, line 31, referring to Figure 3. Figure 3 is a block diagram illustrating the fiber optic transmitter 200 of Figure 2 according to an embodiment of the current invention.[1] Transmitter 200 includes a trellis

[1] Specification, page 5, lines 32-33.

encoder 303 that encodes information to produce digital multilevel symbols.[2] Tomlinson precoder 311 equalizes the digital multilevel symbols to compensate for characteristics of the optical channel.[3] Said equalizing comprises precoding the digital multilevel symbols using a Tomlinson-Harashima precoder.[4] Digital-to-analog (D/A) converter 209 converts the digital multilevel symbols into analog multilevel signals.[5] Laser 211 transmits the analog multilevel signals over the optical channel.[6] The invention of claim 1 is also described in other parts of the application, such as in the Summary of the Invention section.

Claims 5-9 are dependent upon claim 1.

Claim 11 is directed to a method for high speed transmission on an optical channel. Pursuant to said method, information is accepted from a plurality of sources. The information is encoded via a plurality of trellis encoders to produce a plurality of digital multilevel symbols. The plurality of digital multilevel symbols are equalized to compensate for characteristics of the optical channel, said equalizing comprising precoding the digital multilevel symbols using a Tomlinson-Harashima precoder. The plurality of digital multilevel symbols are converted into a plurality of analog multilevel signals. The analog multilevel signals are transmitted by time division multiplexing the plurality of analog multilevel signals onto an optical channel.

The invention of claim 11 is illustratively described in the Specification of the present application at, for example, page 5, line 32 – page 7, line 31, referring to Figure 3. Figure 3 is a block diagram illustrating the fiber optic transmitter 200 of Figure 2 according to an embodiment of the current invention.[7] Figure 2 shows the trellis encoder 201 accepting data from a plurality of sources. Transmitter 200 includes a trellis encoder 303 that encodes information to produce digital multilevel symbols.[8] Tomlinson precoder 311 equalizes the digital multilevel symbols to compensate for characteristics of

---

[2] Specification, page 5, lines 34 – page 6, line 10.
[3] Specification, page 6, lines 11-18.
[4] Specification, page 7, lines 15-25.
[5] Specification, page 7, lines 26-28.
[6] Specification, page 4, lines 14-15.
[7] Specification, page 5, lines 32-33.
[8] Specification, page 5, lines 34 – page 6, line 10.

the optical channel.[9] Said equalizing comprises precoding the digital multilevel symbols using a Tomlinson-Harashima precoder.[10] Digital-to-analog (D/A) converter 209 converts the digital multilevel symbols into analog multilevel signals.[11] Laser 211 transmits the analog multilevel signals over the optical channel.[12] Page 5, lines 23-29, explains that the trellis encoder, equalizer, etc., may be replicated multiple times and the signals time multiplexed from such parallel components in order to couple them in and out of a single fiber channel. The invention of claim 11 is also described in other parts of the application, such as in the Summary of the Invention section.

Claims 12, 16, 18-20, 22 and 23 are dependent upon claim 11.

Claim 28 is directed to a method of signaling over an optical channel. Pursuant to said method, data is accepted from a source and the data is trellis encoded. The data is equalized, said equalizing comprising precoding the data using a Tomlinson-Harashima precoder. The equalized encoded data is coupled into an optical channel and the data is conveyed over the optical channel. Data is accepted from the optical channel and decoded. The decoded data is provided to an interface.

The invention of claim 28 is illustratively described in the Specification of the present application at, for example, page 3, line 29 – page 7, line 31, referring to Figures 2 and 3. Figure 2 is a block diagram of an optical communication system according to an embodiment of the invention.[13] Figure 3 is a block diagram illustrating the fiber optic transmitter 200 of Figure 2 according to an embodiment of the current invention.[14] Transmitter 200 includes a trellis encoder 201 that encodes information to produce digital multilevel symbols.[15] Equalizer 207 equalizes the digital multilevel symbols to compensate for characteristics of the optical channel.[16] Said equalizing comprises precoding the digital multilevel symbols using a Tomlinson-Harashima precoder.[17] Laser

---

9 Specification, page 6, lines 11-18.
10 Specification, page 7, lines 15-25.
11 Specification, page 7, lines 26-28.
12 Specification, page 4, lines 14-15.
13 Specification, page 3, lines 29-30.
14 Specification, page 5, lines 32-33.
15 Specification, page 3, lines 31-34.
16 Specification, page 4, lines 5-6.
17 Specification, page 7, lines 15-25.

211 transmits the analog multilevel signals over the optical channel.[18] Trellis decoder 219 decodes data accepted from the optical channel.[19] The data output of the PCS 221 is provided to a user interface.[20] The invention of claim 28 is also described in other parts of the application, such as in the Summary of the Invention section.

Claim 31 is dependent upon claim 28.

Claim 32 is directed to an apparatus for transmitting information on an optical channel. The apparatus includes a trellis encoder, an equalizer, a digital-to-analog converter, and an analog-signal-to-optical converter. The trellis encoder accepts digital information and produces digital multilevel signals. The equalizer accepts the digital multilevel signals and produces equalized digital multilevel signals. The equalizer comprises a Tomlinson-Harashima precoder. The digital-to-analog converter accepts the equalized digital multilevel signals and produces analog multilevel signals. The analog-signal-to-optical converter converts the analog signal to an optical signal for coupling into an optical channel.

The invention of claim 32 is illustratively described in the Specification of the present application at, for example, page 5, line 32 – page 7, line 31, referring to Figure 3. Figure 3 is a block diagram illustrating the fiber optic transmitter 200 of Figure 2 according to an embodiment of the current invention.[21] Transmitter 200 includes a trellis encoder 303 that encodes information to produce digital multilevel symbols.[22] Tomlinson precoder 311 equalizes the digital multilevel symbols to compensate for characteristics of the optical channel.[23] Said equalizing comprises precoding the digital multilevel symbols using a Tomlinson-Harashima precoder.[24] Digital-to-analog (D/A) converter 209 converts the digital multilevel symbols into analog multilevel signals.[25] Laser 211 transmits the analog multilevel signals over the optical channel.[26] The

---

[18] Specification, page 4, lines 14-15.
[19] Specification, page 4, lines 25-26.
[20] Specification, page 4, lines 29-30.
[21] Specification, page 5, lines 32-33.
[22] Specification, page 5, lines 34 – page 6, line 10.
[23] Specification, page 6, lines 11-18.
[24] Specification, page 7, lines 15-25.
[25] Specification, page 7, lines 26-28.
[26] Specification, page 4, lines 14-15.

invention of claim 32 is also described in other parts of the application, such as in the Summary of the Invention section.

Claims 36 and 37 are dependent upon claim 32.

Claim 38 is directed to an apparatus for concurrently transmitting a plurality of data signals over an optical channel. The apparatus includes a plurality of trellis encoders, a plurality of equalizers, a converter, and an optical source. The plurality of trellis encoders accept a plurality of data signals and produce a plurality of digital multilevel signals. The plurality of equalizers accept the plurality of digital multilevel signals and produce a plurality of equalized digital multilevel signals. Each equalizer comprises a Tomlinson-Harashima precoder. The converter accepts the plurality of equalized digital multilevel signals and produces a plurality of analog multilevel signals. The optical source receives the plurality of analog multilevel signals and produces a light output proportional to the level of successive analog multilevel signals for driving an optical channel.

The invention of claim 38 is illustratively described in the Specification of the present application at, for example, page 5, line 32 – page 7, line 31, referring to Figure 3. Figure 3 is a block diagram illustrating the fiber optic transmitter 200 of Figure 2 according to an embodiment of the current invention.[27] Figure 2 shows the trellis encoder 201 accepting data from a plurality of sources. Transmitter 200 includes a trellis encoder 303 that encodes information to produce digital multilevel symbols.[28] Tomlinson precoder 311 equalizes the digital multilevel symbols to compensate for characteristics of the optical channel.[29] Said equalizing comprises precoding the digital multilevel symbols using a Tomlinson-Harashima precoder.[30] Digital-to-analog (D/A) converter 209 converts the digital multilevel symbols into analog multilevel signals.[31] Laser 211 receives the plurality of analog multilevel signals and produces a light output proportional to the level of successive analog multilevel signals for driving an optical channel.[32] Page 5, lines 23-29, explains that the trellis encoder, equalizer, etc., may be

---

[27] Specification, page 5, lines 32-33.
[28] Specification, page 5, lines 34 – page 6, line 10.
[29] Specification, page 6, lines 11-18.
[30] Specification, page 7, lines 15-25.
[31] Specification, page 7, lines 26-28.
[32] Specification, page 4, lines 14-23.

replicated multiple times and the signals time multiplexed from such parallel components in order to couple them in and out of a single fiber channel. The invention of claim 38 is also described in other parts of the application, such as in the Summary of the Invention section.

Claim 41 is dependent upon claim 38.

Claim 42 is directed to an apparatus for concurrently transmitting a plurality of data signals over an optical channel. The apparatus includes a plurality of trellis encoders, a plurality of equalizers, a digital-to-analog converter, and an optical source. The plurality of trellis encoders accept a plurality of data signals and produce a plurality of digital multilevel signals. The plurality of equalizers accept the plurality of digital multilevel signals and produce a plurality of equalized digital multilevel signals. Each equalizer comprises a Tomlinson-Harashima precoder. The digital-to-analog converter sequentially accepts the plurality of equalized digital multilevel signals and produces a plurality of sequential analog multilevel signals. The optical source receives the plurality of analog multilevel signals for driving an optical channel.

The invention of claim 42 is illustratively described in the Specification of the present application at, for example, page 5, line 32 – page 7, line 31, referring to Figure 3. Figure 3 is a block diagram illustrating the fiber optic transmitter 200 of Figure 2 according to an embodiment of the current invention.[33] Figure 2 shows the trellis encoder 201 accepting data from a plurality of sources. Transmitter 200 includes a trellis encoder 303 that encodes information to produce digital multilevel symbols.[34] Tomlinson precoder 311 equalizes the digital multilevel symbols to compensate for characteristics of the optical channel.[35] Said equalizing comprises precoding the digital multilevel symbols using a Tomlinson-Harashima precoder.[36] Digital-to-analog (D/A) converter 209 sequentially accepts the plurality of equalized digital multilevel signals and produces a plurality of sequential analog multilevel signals.[37] Laser 211 receives the plurality of analog multilevel signals for driving an optical channel.[38] Page 5, lines 23-

[33] Specification, page 5, lines 32-33.
[34] Specification, page 5, lines 34 – page 6, line 10.
[35] Specification, page 6, lines 11-18.
[36] Specification, page 7, lines 15-25.
[37] Specification, page 7, lines 26-28 and page 4, lines 24-25.
[38] Specification, page 4, lines 14-23.

29, explains that the trellis encoder, equalizer, etc., may be replicated multiple times and the signals time multiplexed from such parallel components in order to couple them in and out of a single fiber channel. The invention of claim 42 is also described in other parts of the application, such as in the Summary of the Invention section.

Claim 45 is dependent upon claim 42.

Claim 57 is directed to a method of signaling over an optical channel. Pursuant to said method, data is accepted from a source and the data is multilevel modulated. The data is equalized, said equalizing comprising precoding the data using a Tomlinson-Harashima precoder. The equalized encoded data is coupled into an optical channel and the data is conveyed over the optical channel. Data is accepted from the optical channel and decoded. The decoded data is provided to an interface.

The invention of claim 57 is illustratively described in the Specification of the present application at, for example, page 3, line 29 – page 7, line 31, referring to Figures 2 and 3. Figure 2 is a block diagram of an optical communication system according to an embodiment of the invention.[39] Figure 3 is a block diagram illustrating the fiber optic transmitter 200 of Figure 2 according to an embodiment of the current invention.[40] Transmitter 200 includes a trellis encoder 201 that multilevel modulates received data to produce digital multilevel symbols.[41] Equalizer 207 equalizes the digital multilevel symbols to compensate for characteristics of the optical channel.[42] Said equalizing comprises precoding the digital multilevel symbols using a Tomlinson-Harashima precoder.[43] Laser 211 transmits the analog multilevel signals over the optical channel.[44] Trellis decoder 219 decodes data accepted from the optical channel.[45] The data output of the PCS 221 is provided to a user interface.[46] The invention of claim 57 is also described in other parts of the application, such as in the Summary of the Invention section.

Claim 60 is dependent upon claim 57.

---

[39] Specification, page 3, lines 29-30.
[40] Specification, page 5, lines 32-33.
[41] Specification, page 3, lines 31-34.
[42] Specification, page 4, lines 5-6.
[43] Specification, page 7, lines 15-25.
[44] Specification, page 4, lines 14-15.
[45] Specification, page 4, lines 25-26.
[46] Specification, page 4, lines 29-30.

Claim 57 is directed to a method of signaling over an optical channel. Pursuant to said method, data is accepted from a source and the data is multilevel modulated. The data is equalized, said equalizing comprising precoding the data using a Tomlinson-Harashima precoder. The equalized encoded data is coupled into an optical channel and the data is conveyed over the optical channel. Data is accepted from the optical channel, converted to digital data, and decoded. The decoded data is provided to an interface.

The invention of claim 61 is illustratively described in the Specification of the present application at, for example, page 3, line 29 – page 7, line 31, referring to Figures 2 and 3. Figure 2 is a block diagram of an optical communication system according to an embodiment of the invention.[47] Figure 3 is a block diagram illustrating the fiber optic transmitter 200 of Figure 2 according to an embodiment of the current invention.[48] Transmitter 200 includes a trellis encoder 201 that multilevel modulates received data to produce digital multilevel symbols.[49] Equalizer 207 equalizes the digital multilevel symbols to compensate for characteristics of the optical channel.[50] Said equalizing comprises precoding the digital multilevel symbols using a Tomlinson-Harashima precoder.[51] Laser 211 transmits the analog multilevel signals over the optical channel.[52] Analog-to-digital converter 217 converts data accepted from the optical channel to digital data.[53] Trellis decoder 219 decodes the digital data.[54] The data output of the PCS 221 is provided to a user interface.[55] The invention of claim 61 is also described in other parts of the application, such as in the Summary of the Invention section.

Claim 64 is dependent upon claim 61.

Claim 65 is directed to an apparatus for transmitting information on an optical channel. The apparatus includes a modulator, an equalizer, a digital-to-analog converter, and an analog-signal-to-optical converter. The modulator accepts digital information and produces digital signals. The equalizer accepts the digital signals and produces equalized

---

[47] Specification, page 3, lines 29-30.
[48] Specification, page 5, lines 32-33.
[49] Specification, page 3, lines 31-34.
[50] Specification, page 4, lines 5-6.
[51] Specification, page 7, lines 15-25.
[52] Specification, page 4, lines 14-15.
[53] Specification, page 4, lines 22-26.
[54] Specification, page 4, lines 26-27.
[55] Specification, page 4, lines 29-30.

digital signals. The equalizer comprises a Tomlinson-Harashima precoder. The digital-to-analog converter accepts the equalized digital signals and produces analog signals. The analog-signal-to-optical converter converts the analog signal to an optical signal for coupling into an optical channel.

The invention of claim 65 is illustratively described in the Specification of the present application at, for example, page 5, line 32 – page 7, line 31, referring to Figure 3. Figure 3 is a block diagram illustrating the fiber optic transmitter 200 of Figure 2 according to an embodiment of the current invention.[56] Transmitter 200 includes a trellis encoder 303 that accepts digital information and produces digital signals.[57] Tomlinson precoder 311 equalizes the digital signals to compensate for characteristics of the optical channel.[58] Said equalizing comprises precoding the digital signals using a Tomlinson-Harashima precoder.[59] Digital-to-analog (D/A) converter 209 converts the digital signals into analog signals.[60] Laser 211 transmits the analog signals over the optical channel.[61] The invention of claim 65 is also described in other parts of the application, such as in the Summary of the Invention section.

Claims 69 and 70 are dependent upon claim 65.

Claim 71 is directed to an apparatus for concurrently transmitting a plurality of data signals over an optical channel. The apparatus includes a plurality of modulators, a plurality of equalizers, a converter, and an optical source. The plurality of modulators accept a plurality of data signals and produce a plurality of digital signals. The plurality of equalizers accept the plurality of digital signals and produce a plurality of equalized digital signals. Each equalizer comprises a Tomlinson-Harashima precoder. The converter accepts the plurality of equalized digital signals and produces a plurality of analog signals. The optical source receives the plurality of analog signals and produces a light output proportional to the level of successive analog signals for driving an optical channel.

---

[56] Specification, page 5, lines 32-33.
[57] Specification, page 5, lines 34 – page 6, line 10.
[58] Specification, page 6, lines 11-18.
[59] Specification, page 7, lines 15-25.
[60] Specification, page 7, lines 26-28.
[61] Specification, page 4, lines 14-15.

The invention of claim 71 is illustratively described in the Specification of the present application at, for example, page 5, line 32 – page 7, line 31, referring to Figure 3. Figure 3 is a block diagram illustrating the fiber optic transmitter 200 of Figure 2 according to an embodiment of the current invention.[62] Figure 2 shows the trellis encoder 201 accepting data from a plurality of sources. Trellis encoder 303 produces digital signals.[63] Tomlinson precoder 311 equalizes the digital signals to compensate for characteristics of the optical channel.[64] Said equalizing comprises precoding the digital signals using a Tomlinson-Harashima precoder.[65] Digital-to-analog (D/A) converter 209 converts the digital multilevel signals into analog multilevel signals.[66] Laser 211 receives the plurality of analog signals and produces a light output proportional to the level of successive analog signals for driving an optical channel.[67] Page 5, lines 23-29, explains that the trellis encoder, equalizer, etc., may be replicated multiple times and the signals time multiplexed from such parallel components in order to couple them in and out of a single fiber channel. The invention of claim 71 is also described in other parts of the application, such as in the Summary of the Invention section.

Claim 74 is dependent upon claim 71.

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

I. Claims 1, 6-9, 11, 12, 18-20, 22, 23, 28, 32, 37, 38, 42, 57, 61, 65, 70 and 71 stand rejected under 35 U.S.C. § 103(a) as being unaptentable over Ling (International Application No. WO/98/39871), in view of any/all of Ungerboeck ("Channel coding with multilevel/phase signals"), Lee ("Convolutional Coding: Fundamentals and Applications"), and Schlegl ("Trellis Coding") and further in view of Uyematsu et al. ("Trellis coded modulation for multilevel photon communication systems"), and Winters et al. ("Reducing the effects of transmission impairments in digital fiber optic systems").

---

[62] Specification, page 5, lines 32-33.
[63] Specification, page 5, lines 34 – page 6, line 10.
[64] Specification, page 6, lines 11-18.
[65] Specification, page 7, lines 15-25.
[66] Specification, page 7, lines 26-28.
[67] Specification, page 4, lines 14-23.

ARGUMENT

I. Claims 1, 6-9, 11, 12, 18-20, 22, 23, 28, 32, 37, 38, 42, 57, 61, 65, 70 and 71 are not obvious under 35 U.S.C. § 103(a) over Ling in view of any/all of Ungerboeck, Lee, and Schlegl and further in view of Uyematsu et al. and Winters et al.

In the Office Action of February 1, 2007, claims 1, 6-9, 11-12, 18-20, 22-23, 28, 32, 37-38, 42, 57, 61, 65 and 70-71 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ling (International Application No. WO/98/39871), in view of any/all of Ungerboeck ("Channel coding with multilevel/phase signals"), Lee ("Convolutional Coding: Fundamentals and Applications"), and Schlegl ("Trellis Coding") and further in view of Uyematsu et al. ("Trellis coded modulation for multilevel photon communication systems"), and Winters et al. ("Reducing the effects of transmission impairments in digital fiber optic systems"). 35 U.S.C. 103(a) states:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

The Supreme Court in *Graham v. John Deere*, 383 U.S. 1, 148 USPQ 459 (1966), laid out the standard of patentability to be applied in obviousness rejections, stating:

> Under § 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or nonobviousness of the subject matter is determined.

Claim 1 is directed to a method for high-speed transmission of information data on an optical channel. The method includes "equalizing the digital multilevel symbols to compensate for characteristics of the optical channel, said equalizing comprising precoding the digital multilevel symbols using a Tomlinson-Harashima precoder; converting the digital multilevel symbols into analog multilevel signals; and transmitting the analog multilevel signals over the optical channel." Thus claim 1 includes performing Tomlinson-Harashima precoding in an optical transmission system.

Appellant submits that this is not taught or suggested by the cited art. The only cited art that teaches Tomlinson-Harashima precoding is Ling, which is not directed to an optical transmission system. The only transmission medium referred to in Ling is copper (see page 4, last paragraph). On page 3 of the final Office Action, the Examiner acknowledges that the system of Ling in view of any/all of Ungerboeck, Lee and Schlegl, and further in view of Uyematsu, fails to disclose "equalizing the digital multilevel symbols to compensate for characteristics of the optical channel." The Examiner goes on to assert that equalizing digital multilevel symbols to compensate for characteristics of the optical channel is obvious because "performing equalization in optical systems is well-known in the art, as shown by Winters."[68] However, Winters does *not* teach performing Tomlinson-Harashima precoding. Appellant submits that it would not have been obvious to one of ordinary skill in the art at the time that the invention was made to implement Tomlinson-Harashima precoding in an optical transmission system because optical transmission systems have different channel characteristics and present different challenges than copper cabling transmission systems. In the Office Action, the Examiner argues that it would be obvious to perform trellis coded modulation (TCM) in an optical transmission system, but fails to argue that it would be obvious to use Tomlinson-Harashima precoding in an optical transmission system. Appellant submits that it would not have been obvious to one of ordinary skill in the art at the time that the invention was made to implement Tomlinson-Harashima precoding in an optical transmission system for the reasons set forth above. The Examiner does not provide any motivation to apply the Tomlinson-Harashima precoding of Ling to an optical communication system. Appellant submits that there is no suggestion to combine the Tomlinson-Harashima equalization on the transmit side of Ling with Uyematsu's trellis coding for optical systems. "To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly suggest the claimed invention or the examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references."[69] Appellant submits that there is no suggestion in either Ling, Uyematsu or Winters (nor in Ungerboeck, Lee or Schlegl) to apply Ling's

---

[68] Final Office Action, dated July 11, 2007, page 4.
[69] *Ex Parte Clapp*, 227 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985).

Tomlinson-Harashima precoding to an optical system. Therefore, Appellant submits that claim 1, and claims 5-9 depending therefrom, are allowable over the cited art.

In *Graham v. John Deere*, the Supreme Court held regarding obviousness inquiries that "Such secondary considerations as commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented."[70] The problem of intersymbol interference represents a long-felt need in the art of optical transmission systems, as evidenced by the Examiner's acknowledgement on page 10 of the final Office Action that "both (optical transmission systems and copper cabling transmission systems) are subject to the problem of intersymbol interference." The present invention's use of Tomlinson-Harashima precoding to compensate for characteristics of the optical channel represents a solution to this long-felt need. Yet the Examiner, who has clearly done extensive searching,[71] has failed to uncover a single instance of this solution for optical transmission systems. This long-felt but unsolved need is further evidence that the invention claimed in claim 1 is not obvious.

Independent claims 11, 23, 28, 32, 38, 42, 57, 61, 65 and 71 contain limitations similar to limitations contained in claim 1 and were rejected on grounds similar to those used to reject claim 1. Appellant submits that claims 11, 23, 28, 32, 38, 42, 57, 61, 65 and 71, and all claims depending therefrom, are allowable over the cited art for the reasons set forth above with respect to claim 1.

In view of the foregoing amendments, Appellant respectfully requests allowance of claims 1, 5-9, 11, 12, 16, 18-20, 22, 23, 28, 31, 32, 36-38, 41, 42, 45, 57, 60, 61, 64, 65, 69-71 and 74.

II. Conclusion

For at least the foregoing reasons, Appellant submits that claims 1, 5-9, 11, 12, 16, 18-20, 22, 23, 28, 31, 32, 36-38, 41, 42, 45, 57, 60, 61, 64, 65, 69-71 and 74 are not obvious in view of the cited art. Reversal of the Examiner's rejection and issuance of a patent on the application are therefore requested.

---

[70] *Graham v. John Deere*, 383 U.S. 1, 148 USPQ 459 (1966)

[71] As evidenced by the citation of five scholarly papers and one patent publication in rejecting claim 1.

The Commissioner is hereby authorized to charge $510 (to cover the Brief on Appeal Fee) and any additional fees or credit any overpayment to the deposit account of McAndrews, Held & Malloy, Account No. 13-0017.

Dated: July 2, 2008

Respectfully submitted,

John A Wiberg
Registration No. 44,401
Attorney for appellant

McANDREWS, HELD & MALLOY, LTD.
500 West Madison Street, 34th Floor
Chicago, IL 60661
Telephone: (312) 775-8000
Facsimile: (312) 775-8100

APPENDIX

(37 C.F.R. § 1.192(c)(9))

The following claims are involved in this appeal:

1. A method for high-speed transmission of information data on an optical channel, the method comprising:

encoding information via a trellis encoder to produce digital multilevel symbols;

equalizing the digital multilevel symbols to compensate for characteristics of the optical channel, said equalizing comprising precoding the digital multilevel symbols using a Tomlinson-Harashima precoder;

converting the digital multilevel symbols into analog multilevel signals; and

transmitting the analog multilevel signals over the optical channel.

5. The method of claim 1 wherein equalizing the digital multilevel symbols comprises precoding the digital multilevel symbols using a dynamic limiting precoder.

6. The method of claim 1 wherein the information that is encoded comprises input bits and wherein encoding the information includes mapping the input bits into digital multilevel symbols.

7. The method of claim 1 wherein transmitting the analog multilevel signals over an optical channel comprises modulating the intensity of a light source according to the level of the analog multilevel signals.

8. The method of claim 1 wherein transmitting the analog multilevel signals over an optical channel comprises modulating laser intensity according to the level of the analog multilevel signals.

9. A method as in claim 1 wherein equalizing the digital multilevel symbols to compensate for the laser and channel characteristics comprises:

characterizing the channel; and

applying an inverse characterization of the channel to the digital multilevel symbols.

11. A method for high speed transmission on an optical channel, the method comprising:

accepting information from a plurality of sources;

encoding the information via a plurality of trellis encoders to produce a plurality of digital multilevel symbols;

equalizing the plurality of digital multilevel symbols to compensate for characteristics of the optical channel, said equalizing comprising precoding the digital multilevel symbols using a Tomlinson-Harashima precoder;

converting the plurality of digital multilevel symbols into a plurality of analog multilevel signals; and

transmitting the analog multilevel signals by time division multiplexing the plurality of analog multilevel signals onto an optical channel.

12. A method as in claim 11 wherein the accepted information comprises input bits and wherein encoding the information comprises:

mapping the input bits into digital multilevel symbols .

16. The method of claim 11 wherein equalizing the digital multilevel symbols comprises precoding the digital multilevel symbols using a dynamic limiting precoder.

18. The method of claim 11 wherein transmitting the analog multilevel signals over an optical channel comprises modulating the intensity of a light source according to the level of the analog multilevel signals.

19. The method of claim 11 wherein transmitting the analog multilevel signals over an optical channel comprises modulating laser intensity according to the level of the analog multilevel signals.

20. A method as in claim 11 wherein equalizing the digital multilevel symbols to compensate for the laser and channel characteristics comprises:

characterizing the channel; and

using an inverse characterization of the channel to modify the digital multilevel symbols.

22. The method of claim 11 wherein converting the plurality of digital multilevel symbols into a plurality of analog multilevel signals comprises:

accepting the plurality of multilevel symbols successively into a single analog to digital converter; and

successively converting the plurality of symbols into analog multilevel signals.

23. The method of claim 11 wherein converting the plurality of digital multilevel symbols into a plurality of analog multilevel signals comprises:

accepting the plurality of multilevel symbols successively into a plurality of analog to digital converters; and

converting the plurality of symbols into an analog representation; and

successively combining the analog multilevel signals into a succession of analog multilevel signals.

28. A method of signaling over an optical channel, the method comprising:

accepting data from a source;

trellis encoding the data;

equalizing the data, said equalizing comprising precoding the data using a Tomlinson- Harashima precoder;

coupling the equalized encoded data into an optical channel;

conveying the data over the optical channel;

accepting data from the optical channel;

decoding the data accepted from the optical channel; and

providing the decoded data to an interface.

31. A method as in claim 28 wherein equalizing the data comprises applying a dynamic limiting precoding.

32. An apparatus for transmitting information on an optical channel, the apparatus comprising:

a trellis encoder for accepting digital information and producing digital multilevel signals;

an equalizer that accepts the digital multilevel signals and produces equalized digital multilevel signals, the equalizer comprising a Tomlinson-Harashima precoder;

a digital-to-analog converter that accepts the equalized digital multilevel signals and produces analog multilevel signals; and

an analog signal to optical converter that converts the analog signal to an optical signal for coupling into an optical channel.

36. An apparatus as in claim 32 wherein the equalizer is a dynamic limiting precoder.

37. An apparatus as in claim 32 wherein the analog signal to optical converter includes a laser.

38. An apparatus for concurrently transmitting a plurality of data signals over an optical channel, the apparatus comprising:

a plurality of trellis encoders that accept a plurality of data signals and produce a plurality of digital multilevel signals;

a plurality of equalizers that accept the plurality of digital multilevel signals and produce a plurality of equalized digital multilevel signals, each equalizer comprising a Tomlinson-Harashima precoder;

a converter that accepts the plurality of equalized digital multilevel signals and produces a plurality of analog multilevel signals; and

an optical source that receives the plurality of analog multilevel signals and produces a light output proportional to the level of successive analog multilevel signals for driving an optical channel.

41. An apparatus as in claim 38 wherein the plurality of equalizers comprise at least one dynamic limiting precoder.

42. An apparatus for concurrently transmitting a plurality of data signals over an optical channel, the apparatus comprising:

a plurality of trellis encoders that accept a plurality of data signals and produce a plurality of digital multilevel signals;

a plurality of equalizers that accept the plurality of digital multilevel signals and produce a plurality of equalized digital multilevel signals, each equalizer comprising a Tomlinson-Harashima precoder;

a digital-to-analog converter that sequentially accepts the plurality of equalized digital multilevel signals and produces a plurality of sequential analog multilevel signals; and

an optical source that receives the plurality of analog multilevel signals for driving an optical channel.

45. An apparatus as in claim 42 wherein the plurality of equalizers comprise at least one dynamic limiting precoder.

57. A method of signaling over an optical channel, the method comprising:

accepting data from a source;

multilevel modulating the data;

equalizing the data, said equalizing comprising precoding the data using a Tomlinson- Harashima precoder;

coupling the equalized encoded data into an optical channel;

conveying the data over the optical channel;

accepting data from the optical channel;

decoding the data accepted from the optical channel; and

providing the decoded data to an interface.

60. A method as in claim 57 wherein equalizing the data comprises applying a dynamic limiting precoding.

61. A method of signaling over an optical channel, the method comprising:

accepting data from a source;

multilevel modulating the data;

equalizing the data, said equalizing comprising precoding the data using a Tomlinson-Harashima precoder;

coupling the equalized encoded data into an optical channel;

conveying the data over the optical channel;

accepting data from the optical channel;

converting the data accepted from the optical channel to digital data;

decoding the digital data accepted from the optical channel; and

providing the decoded data to an interface.

64. A method as in claim 61 wherein equalizing the data comprises applying a dynamic limiting precoding.

65. An apparatus for transmitting information on an optical channel, the apparatus comprising:

a modulator for accepting digital information and producing digital signals;

an equalizer that accepts the digital signals and produces equalized digital signals, the equalizer comprising a Tomlinson-Harashima precoder;

a digital-to-analog converter that accepts the equalized digital signals and produces analog signals; and

an analog signal to optical converter that converts the analog signal to an optical signal for coupling into an optical channel.

69. An apparatus as in claim 65 wherein the equalizer is a dynamic limiting precoder.

70. An apparatus as in claim 65 wherein the analog signal to optical converter includes a laser.

71. An apparatus for concurrently transmitting a plurality of data signals over an optical channel, the apparatus comprising:

a plurality of modulators that accept a plurality of data signals and produce a plurality of digital signals;

a plurality of equalizers that accept the plurality of digital signals and produce a plurality of equalized digital signals, each equalizer comprising a Tomlinson-Harashima precoder;

a converter that accepts the plurality of equalized digital multilevel signals and produces a plurality of analog multilevel signals; and

an optical source that receives the plurality of analog signals and produces a light output proportional to the level of successive analog signals for driving an optical channel.

74. An apparatus as in claim 71 wherein the plurality of equalizers comprise at least one dynamic limiting precoder.

EVIDENCE APPENDIX

Not applicable.

RELATED PROCEEDINGS APPENDIX

The Appellant is unaware of any related appeals or interferences.